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Integrating indigenous number systems and indefinite units into mathematics learning: A study on Javanese language and culture

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Abstract

Indonesia continues to face significant challenges in students' mathematical competencies, particularly in foundational numeracy. Addressing this issue requires innovative instructional strategies that are both contextually relevant and culturally responsive. This study explores the traditional mathematical language of the Javanese community as a culturally embedded medium for expressing numerical values and non-standard measurement units. Employing an ethnographic approach, the research combines literature review, field observations, and interviews with a Javanese language expert to examine the role of non-standard numerical expressions in everyday contexts and their potential integration into formal mathematics instruction. The findings reveal that Javanese numerical terms, deeply rooted in daily life, offer a meaningful foundation for enhancing basic numeracy. These culturally grounded expressions can strengthen arithmetic skills, improve conceptual understanding, and increase student engagement. By drawing on local linguistic and cultural practices, the approach bridges students' real-world quantitative experiences with formal mathematical concepts, fostering a more relevant and inclusive learning environment. This study shifts the ethnomathematical focus from geometric motifs to numerical constructs, offering strategic insights for early numeracy instruction. The results provide valuable implications for educators and policymakers seeking to design pedagogically effective curricula that advance foundational numeracy while preserving and honoring indigenous knowledge systems.

Keywords:
Ethnomathematics, Indefinite units, Indigenous number systems, Javanese language, Numbers

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1. INTRODUCTION

Despite Indonesia's long-standing participation in the Trends in International Mathematics and Science Study (TIMSS) since 1999, its students have consistently performed below the international average (Thien et al., 2015). TIMSS reports have repeatedly highlighted Indonesian learners' persistent struggles with core aspects of mathematical reasoning, including the application of abstract concepts, the ability to make cross-topic connections, and the articulation of mathematical thinking (Fenanlampir et al., 2019; Mullis et al., 2016; Utomo & Syarifah, 2021). These deficiencies place Indonesian students within the "Low International Benchmark," signifying significant challenges in achieving foundational mathematical competencies expected at the international level.

Similarly, findings from the 2022 Programme for International Student Assessment (PISA) echo these concerns, revealing that many Indonesian students continue to encounter difficulties in understanding, processing, and expressing mathematical ideas through appropriate language (OECD, 2023). Although mathematics is frequently referred to as a universal language (Hoffert, 2009), the inability to grasp and use mathematical terminology effectively hampers students' problem-solving capabilities and their development of higher-order thinking skills (Torres-Peña et al., 2025). Further empirical studies indicate that these challenges often stem from weak early numeracy skills, including limited number recognition and difficulties with basic arithmetic operations—both of which are foundational for subsequent mathematical learning (Gashaj et al., 2023; Jäder & Johansson, 2025; Nanda & Rani, 2025). These issues are particularly pronounced in elementary education, where the initial stages of mathematical cognition are formed.

A contributing factor to these persistent difficulties is the limited integration of innovative, engaging, and culturally responsive teaching methodologies within mathematics instruction (Prahmana, 2022; Prahmana et al., 2023). There is a growing consensus that conventional approaches, which emphasize procedural fluency in isolation, are insufficient to foster meaningful mathematical understanding. In response, ethnomathematics has emerged as a promising educational paradigm that examines the mathematical practices embedded within cultural contexts, particularly those of non-formal or indigenous communities (D'Ambrosio, 2016; Prahmana & D'Ambrosio, 2020). Recent studies have underscored the relevance of local culture in mathematics education, emphasizing the value of culturally contextualized learning experiences (Batiibwe, 2024; Kusuma et al., 2024; Lidinillah et al., 2022; Turmuzi et al., 2023). Ethnomathematical research frequently focuses on spatial and visual representations—including traditional patterns (Khasanah et al., 2025), architecture (Orey & Rosa, 2021), numeric systems (Prahmana, 2020), and geometric forms (Azmi et al., 2025; Nurcahyo et al., 2024)—as pedagogical tools that bridge cultural knowledge and formal mathematics.

These concerns are particularly salient in the context of early childhood and elementary mathematics education, where learners begin to construct fundamental understandings of number and quantity through everyday experiences. Yet, dominant instructional models often overlook the sociocultural and linguistic dimensions that significantly influence how students interpret and engage with mathematical ideas. In multilingual and multicultural educational settings, the language of instruction can either

facilitate conceptual understanding or exacerbate barriers to learning (Erath et al., 2021; Lyu et al., 2024; Morgan, 2005). As Moschkovich (2007) argues, mathematical discourse should not be narrowly defined by vocabulary alone; rather, it should encompass broader processes of reasoning, explaining, and making meaning, all of which are deeply situated in students' sociocultural and linguistic realities. These insights underscore the importance of adopting pedagogical approaches that are not only mathematically rigorous but also culturally and linguistically responsive.

1.1. Early Numeracy and Cultural Foundations

Early numeracy is widely recognized as a critical foundation for the development of long-term mathematical competence (Jordan et al., 2010). Empirical research has demonstrated that early proficiency in skills such as counting, quantity comparison, and number recognition is strongly associated with later academic achievement in mathematics (Litkowski et al., 2020; Liu et al., 2025). However, these foundational competencies do not emerge in isolation from cultural and linguistic contexts. Rather, they are deeply influenced by children's everyday social interactions and the linguistic resources available within their communities (Jurdak, 2020). Drawing from Vygotsky's sociocultural theory, cognitive development—including the acquisition of mathematical knowledge—is mediated through culturally embedded tools such as language. This perspective emphasizes that early mathematical understanding is not solely a cognitive process, but a socially and culturally situated one, shaped through participation in meaningful activities within a child's environment (Vygotsky, 1978).

In light of this theoretical framing, the traditional linguistic landscape of Javanese culture presents a valuable yet underexplored source of early mathematical knowledge. The Javanese language encompasses a diverse set of numerical expressions and estimative measurement terms that reflect culturally specific ways of perceiving and communicating quantity (Prahmana, 2020). For example, cardinal terms such as *setunggal* (one) and *limalas* (fifteen), along with non-standard units like *segenggam* (a handful), *secuwil* (a pinch), and *saklempit* (a small bundle), embody indigenous quantification practices that are both contextually meaningful and cognitively accessible to young learners. These vernacular forms provide opportunities to align early mathematics instruction with learners' cultural and linguistic backgrounds, potentially enriching numeracy development by making abstract concepts more relatable and grounded in familiar experiences.

1.2. Ethnomathematics and the Indonesian Context

Ethnomathematics, first conceptualized by D'Ambrosio (2016), underscores the notion that mathematical knowledge is not culturally neutral but is instead embedded in the daily practices, beliefs, and artifacts of diverse communities. In the Indonesian context, ethnomathematics has garnered increasing attention as an approach for making mathematics education more culturally relevant and contextually meaningful (Hidayati & Prahmana, 2022; Prahmana & D'Ambrosio, 2020). A number of studies have demonstrated the pedagogical value of incorporating cultural elements, such as the use of shadow puppetry to teach set theory (Prahmana & Istiandaru, 2021) and the *Tedhak Siten* ceremony to introduce

basic geometric and counting concepts (Wiryanto et al., 2022). However, despite these important contributions, the ethnomathematical literature in Indonesia has largely centered on spatial and geometric representations, with considerably less attention given to foundational mathematical domains such as number systems and arithmetic operations. As a result, the full potential of ethnomathematics to support core competencies in mathematical literacy, numeracy, and logical reasoning—particularly in relation to number concepts—remains underutilized (Deda et al., 2024; Payadnya et al., 2025).

This trend is further corroborated by recent systematic reviews of ethnomathematics research, which reveal a disproportionate focus on geometric domains within the Indonesian context (Hendriyanto et al., 2023; Nasrum et al., 2025). Studies by Sunzuma and Maharaj (2021; 2022), and Kyeremeh et al. (2023; 2025) indicate that geometry is the most frequently explored mathematical strand, followed by algebra, set theory, and—much less frequently—numerical topics. Such an imbalance suggests a significant gap in research on culturally rooted number systems, indigenous numeracy practices, and non-standard units of measurement. Without a more inclusive exploration of numerical aspects within ethnomathematical contexts, opportunities to enhance students' early mathematical thinking and culturally responsive pedagogy remain limited. Bridging this gap requires expanding the scope of research beyond geometry to include the rich numerical and quantitative knowledge embedded in cultural and linguistic traditions.

Theoretical perspectives in the field affirm the mathematical significance of cultural and linguistic systems. Scholars such as Barton (2008) and Gerdes (2009) argue that every cultural group develops its own internal logic, classification schemes, and numerical frameworks, often transmitted through language. In support of this view, Risdiyanti et al. (2019) found that students frequently use their native languages to express mathematical reasoning, indicating that language is not merely a medium of communication but a cognitive tool that shapes mathematical understanding. In traditional Javanese culture, expressions such as *pirang-pirang* (many), *sawentara* (some), *semene* (this much), *sethithik* (a little), and *okeh* (a lot) function as linguistic markers for conveying indefinite quantities. These vernacular expressions not only reflect culturally specific ways of quantifying but also offer insights into the mental models that learners use to process and internalize numerical information.

Given Indonesia's extensive cultural and linguistic diversity, the mathematical language found within Javanese culture offers a promising avenue for addressing the current research imbalance and enriching mathematics education. As one of the largest and most linguistically distinct ethnic groups in Indonesia, the Javanese community provides a well-documented example of how traditional language practices encode mathematical ideas (Prahmana, 2020). In multilingual learning environments, students often struggle to reconcile formal mathematical vocabulary with the linguistic and conceptual frameworks of their everyday lives (Moschkovich, 2007). In this regard, Moschkovich (2021) emphasizes that language plays a dual role: it facilitates communication and simultaneously embodies the cognitive structures underlying mathematical thought. Leveraging culturally embedded mathematical language, therefore, can serve as a bridge between abstract mathematical

concepts and learners' concrete experiences, enhancing both comprehension and engagement in early mathematics learning.

However, such vernacular mathematical language remains underutilized in formal education settings. There is limited empirical research examining how these traditional forms can be integrated into teaching practices to support numeracy development in early learners. Therefore, this study explores the mathematical language embedded within Javanese cultural practices, with a particular emphasis on number concepts and non-standard units of measurement. Through a linguistic and ethnomathematical analysis of traditional expressions and culturally specific quantification terms, the research seeks to identify number-related ideas that are deeply rooted in Javanese culture. It aims to interpret these concepts through a mathematical lens to uncover their potential pedagogical value, especially for early numeracy development.

Grounded in the principles of culturally responsive pedagogy and the theoretical foundations of ethnomathematics, this study positions indigenous mathematical language as a meaningful entry point for mathematics learning. By contextualizing mathematical ideas within the lived experiences, linguistic structures, and cultural heritage of Javanese communities, the research offers a pathway to move beyond procedural instruction toward a more holistic and culturally affirming mathematics education. This approach not only fosters deeper cognitive engagement among learners but also contributes to the preservation of local knowledge systems with inherent mathematical value. Ultimately, the findings are expected to inform both theoretical discourse and practical strategies in curriculum development, providing educators, researchers, and policymakers with insights into how culturally embedded mathematical knowledge can enhance the inclusivity, relevance, and quality of mathematics education in pluralistic societies such as Indonesia.

2. METHOD

This study aims to explore the cultural aspects of Javanese culture that are related to mathematics in the context of ethnographic research. Koentjaraningrat (2009) explains that ethnographic approaches involve a descriptive focus, shaped by seven cultural elements: language, technology systems, economic systems, social organization, knowledge systems, art, and religion. This approach is employed because ethnomathematics research examines the relationship between a specific culture and the mathematical concepts inherent within that culture. Thus, this study uses an ethnographic approach to describe mathematical elements within the language of the Javanese culture community.

2.1. Participants and Research Setting

The study was conducted in Hargotirto Village, located in the Kokap District of Kulon Progo Regency, within the Special Region of Yogyakarta, an area renowned for its strong preservation of Javanese cultural heritage. This site was purposively selected due to its sustained commitment to maintaining traditional practices, language, and cultural values, particularly those associated with the ancient Javanese language, which constitutes the primary focus of this investigation. The principal participant, referred to pseudonymously as

Mbah Inah, is a respected village elder with extensive knowledge of local linguistic expressions and cultural traditions, especially those involving rare lexical items imbued with philosophical or conceptual significance. Additional insights were obtained from several community leaders and residents who actively contribute to the preservation and transmission of Javanese cultural knowledge, serving as supporting informants throughout the data collection process.

2.2. Data Collection

Data for this study were obtained through a combination of field observations, literature review, document analysis, and semi-structured interviews. The interviews were conducted directly with Mbah Inah (pseudonym), a resident of Hargotirto Village, Kokap District, Kulon Progo Regency, to verify and elaborate on ancient Javanese terms identified during the literature review and field observations. As a respected elder within the community, Mbah Inah possesses a deep and nuanced understanding of the ancient Javanese language. Her expertise was instrumental in interpreting and contextualizing culturally embedded terms, particularly those with philosophical or conceptual significance, thereby enhancing the reliability and cultural authenticity of the linguistic data used in this study.

2.3. Data Analysis

The analysis was carried out qualitatively by examining data from various sources such as books, scholarly articles, observation notes, and interview transcripts. The data were analyzed to uncover both implicit and explicit mathematical concepts that emerge in the language and cultural practices of the Javanese culture community. Triangulation was used as a technique to ensure data validity by comparing interview results, observations, and relevant literature published in the reputable journals.

2.4. Ethical Considerations

This research was conducted with full adherence to research ethics principles, such as respecting participants' privacy and rights, as well as maintaining the confidentiality of informants who preferred to remain anonymous. Oral consent was obtained from participants before the interviews, with clear explanations provided about the purpose of the research and how the data would be used. Additionally, the researcher aimed to avoid disrupting the local cultural and social balance and remained sensitive to the values and norms present within the community.

2.5. Researcher Reflexivity

As researchers with academic backgrounds in mathematics education and a strong interest in local cultural contexts, we recognize that our interpretations may be shaped by personal experiences and disciplinary assumptions. To address this, we adopted a reflexive stance throughout the research process, acknowledging our positionality as outsiders within the community under study. This reflexivity involved systematically documenting our subjective responses during fieldwork and engaging in continuous dialogue with local informants to critically examine and mitigate potential interpretive biases. By remaining

open to indigenous perspectives and cultural meanings, we sought to ensure that the analysis remained grounded in the lived realities of the participants.

3. RESULTS AND DISCUSSION

3.1. Results

This study explores the culturally embedded numerical language commonly used by members of the Javanese community in their daily activities. These unique mathematical expressions, particularly those concerning numbers, are still widely practiced by native Javanese speakers, especially those residing in rural areas. The results of this linguistic and ethnomathematical exploration are organized as follows.

3.1.1. Javanese Numerical Language for Expressing Whole Numbers

In Javanese culture, whole numbers are articulated through distinct classifications, including singular and compound number forms. The community employs a variety of specific terms for compound base numbers, which are further categorized into terms for tens, *las-lasan* (teen numbers), *likuran* (twenties), *atusan* (hundreds), *ewunan* (thousands), *khethen* (tens of thousands), *leksan* (hundreds of thousands), and *yutanan* (millions). The structure and terminology used in these numerical expressions reflect a culturally nuanced understanding of number systems, as illustrated in Figure 1.

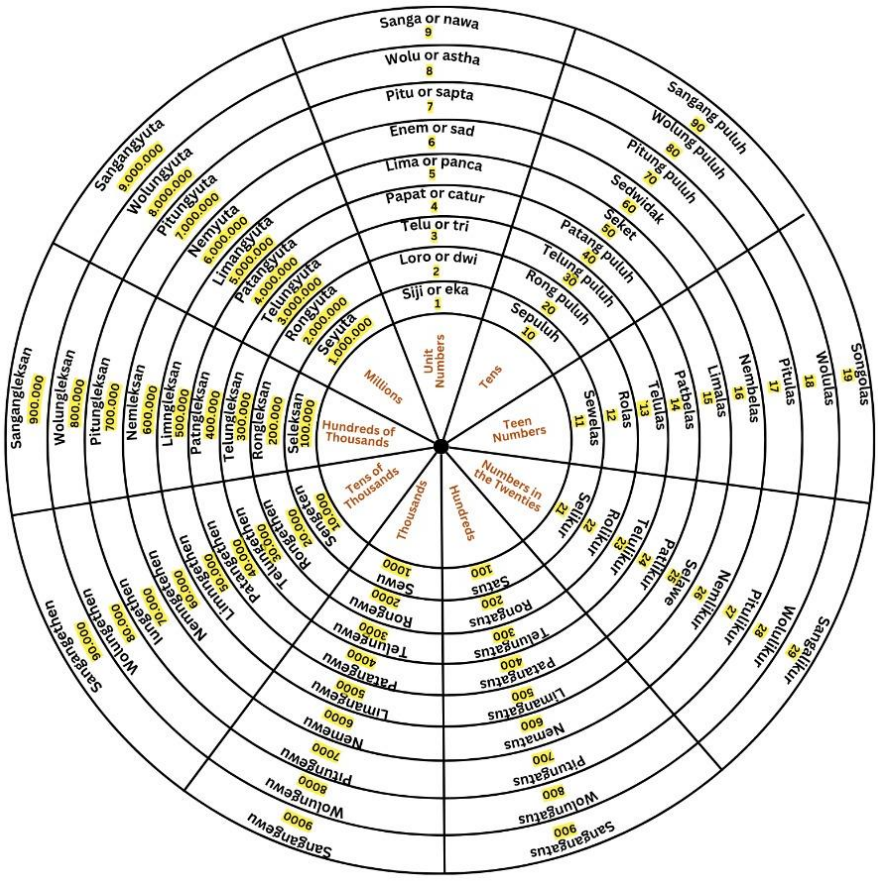

Figure 1. The wheel of Javanese numerical language for whole numbers expression

Interview findings reveal that the Javanese community possesses a structured and culturally distinctive system for naming numbers, ranging from units and tens to hundreds and millions. Terms such as *selikur* (twenty-one), *selawe* (twenty-five), *satus* (one hundred), and *seyuta* (one million) exemplify a localized representation of numbers passed down through generations. These findings reinforce the argument that each culture develops its own ways of conceptualizing, organizing, and articulating mathematical ideas, a perspective central to the theory of ethnomathematics (D'Ambrosio, 2016; Prahmana & D'Ambrosio, 2020; Risdiyanti & Prahmana, 2021; Rosa & Orey, 2011). The numerical language used by the Javanese people is a vivid manifestation of ethnomathematical practice, where mathematics is not only formally taught but also lived and enacted through local language and culture.

3.1.2. Javanese Numerical Language for Expressing Fractions

In expressing fractional numbers, the Javanese community commonly uses the term para or its abbreviated form pra to denote the concept of division. In fractional expressions, this prefix appears between the numerator and denominator except in the case of one divided by two, which is more commonly expressed as *separo*, meaning a half. Additionally, terms such as *pralon* (divided by three), *prapat* (divided by four), *praliman* (divided by five), *pranem* (divided by six), *prapiton* (divided by seven), *prawolon* (divided by eight), *prasangan* (divided by nine), and *prasepuluh* (divided by ten) are widely used. Table 1 illustrates several common fractional expressions using this linguistic system.

Table 1. Javanese mathematical terms for expressing fractions

No	Term	Meaning
1	*Separo*	One divided by two
2	*Rong pratelon*	Two divided by three
3	*Telung prapat*	Three divided by four
4	*Patang praliman*	Four divided by five
5	*Liman praenem*	Five divided by six
6	*Telung prapiton*	Three divided by seven
7	*Liman prawolon*	Five divided by eight
8	*Lima pranem*	Five divided by six
9	*Pitung prasangan*	Seven divided by nine
10	*Saprasepuluh*	One divided by ten

The use of mathematical language in Javanese culture reflects a rich integration of local tradition with daily life. The consistent use of the prefix "*pra*" or "*para*" to indicate division e.g., *telung prapat* (three divided by four) or *separo* (one-half) demonstrates a systematic approach to understanding fractions through cultural expression. Such

terminology facilitates informal mathematical understanding and illustrates that number concepts have been internalized within the structure of traditional Javanese language.

This phenomenon parallels research by Supriadi (2022), who found that traditional games, such as *Endog-Endogan* games can be used as a solution to make learning fraction operations easier and more flexible. Similarly, Risdiyanti et al. (2019) demonstrated that incorporating mathematical elements from traditional games, such as kubuk manuk, enhances students' understanding of social arithmetic. These findings underscore the pedagogical potential of integrating local language and practices into mathematics education. Rich linguistic structures, such as those found in Javanese numerical terms, show that communities can grasp mathematical ideas such as division or fractions without reliance on formal notation. Thus, terms like *prapat* or *praliman* function not only as cultural expressions but also as cognitive tools that support mathematical reasoning (Moschkovich, 2021). Integrating such localized terms into mathematics instruction not only preserves cultural heritage but also enhances conceptual understanding and promotes meaningful, contextual learning.

3.1.3. Javanese Numerical Language for Expressing Indefinite Quantities

The Javanese language also includes specialized terms for expressing indefinite quantities. These terms are not tied to precise numerical values but are context-dependent and culturally understood. Table 2 provides examples of these terms.

Table 2. Javanese mathematical terms for indefinite quantities

No	Term	Description
1	*Pirang-pirang*	Indicates a large, unspecified quantity
2	*Sawentara*	Indicates a few, unspecified items
3	*Semene*	Indicates a certain amount; equivalent to "this much" or "some"
4	*Sethihik*	Indicates a small quantity
5	*Okeh*	Indicates a large amount
6	*Puluhan*	Indicates quantities in the tens
7	*Atusan*	Indicates quantities in the hundreds
8	*Ewunan / Maewu-ewu*	Indicates quantities in the thousands
9	*Yutanan / Mayuta-yuta*	Indicates quantities in the millions
10	*Kethenan / Makethi-kethi*	Indicates quantities in the tens of thousands
11	*Leksanan / Maleksa-leksa*	Indicates quantities in the hundreds of thousands

3.1.4. Javanese Numerical Language for Indefinite Measurement Units

Beyond fractions and whole numbers, Javanese numerical language also encompasses culturally specific terms for expressing indeterminate units of measurement. These units are typically associated with specific objects and are deeply rooted in the local cultural context. Figure 2 illustrates some examples of these terms.

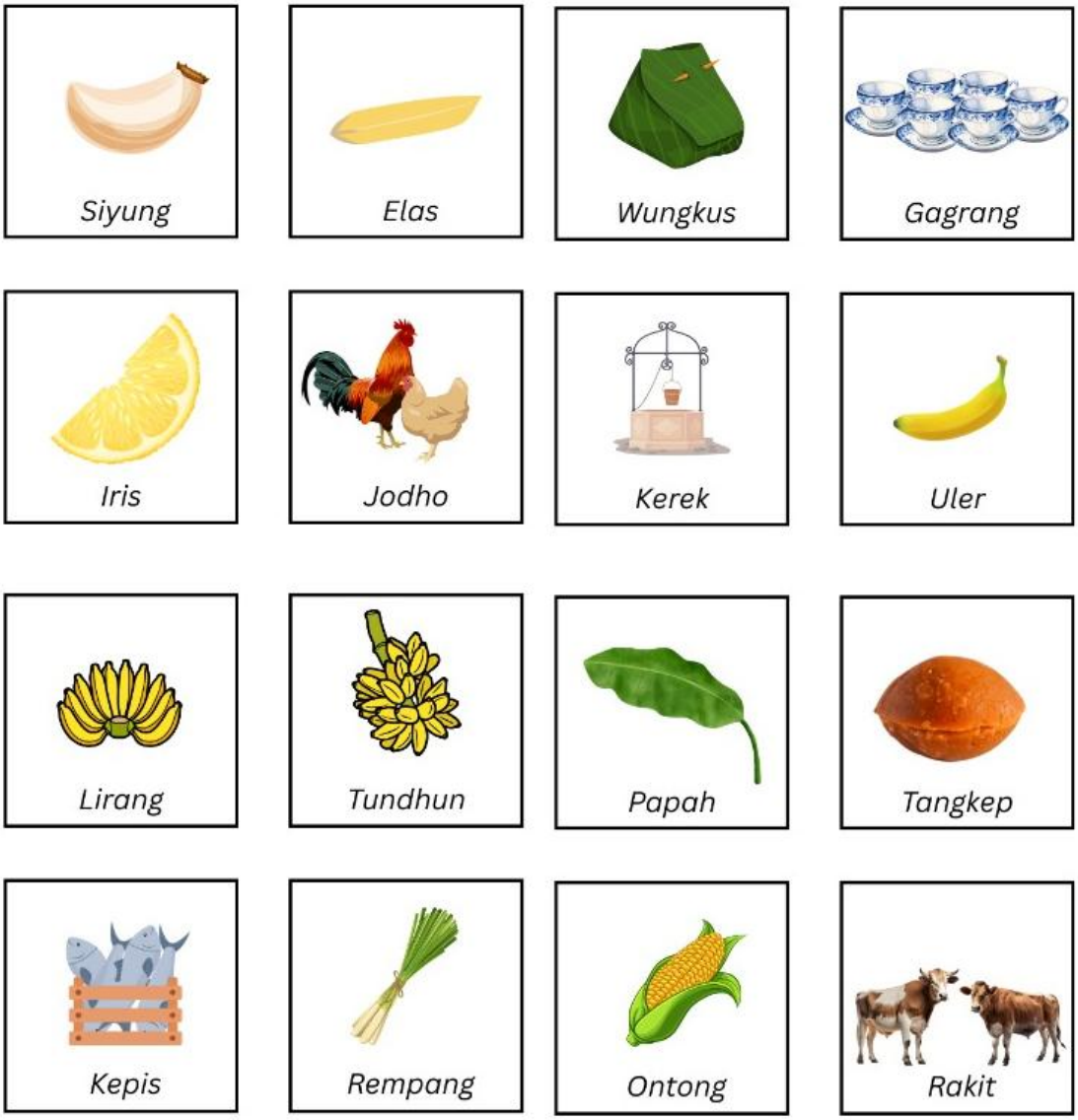

Figure 2. The illustration of Javanese numerical language for indefinite measurement units

In Javanese culture, specific numerical terms are used to denote the quantity of various items based on their physical form or customary grouping as shown in Figure 2. *Siyung* or *sasiyung* refers to a single clove of garlic, while *elas* or *saelas* signifies one grain of rice. Items commonly wrapped such as rice, cigarettes, or noodles are counted using *wungkus* or *sawungkus*, meaning one package. Household utensils like glasses or cups are measured in *gagrang* or *sagagrang*, representing one complete set. Food slices, such as fruits, bread, or meat, are quantified by *iris* or *sairis*, and a male-female pair of animals is termed *jodho* or *sajodho*. The act of pulling a rope, such as raising a flag or drawing water,

is counted as *kerek* or *sakerek*. For bananas, *uler* or *sauler* denotes a single fruit, *lirang* or *salirang* indicates a cluster or hand, and *tundhun* or *satundhun* refers to a full stalk comprising multiple clusters. Large leaf stalks, such as those of banana or coconut leaves, are referred to as *papah* or *sapapah*. In the case of palm sugar molded with half coconut shells, *tangkep* or *satangkep* signifies two pieces. The term *kepis* or *sakepis* is used to denote the number of fish contained in a traditional fish container, typically holding 5–10 fish. A bundle of vegetables, around 7 cm in diameter, is called *rempang* or *sarempang*, and an ear of corn is referred to as *ontong* or *saontong*. Lastly, *rakit* or *sarakit* denotes a pair of four-legged male and female animals, such as cows or goats. These culturally specific terms reflect the practical and context-based numerical expressions embedded in Javanese daily life. These expressions form also part of a culturally contextualized quantification system that does not rely on exact numeric values but instead depends on shared cultural understandings and practical knowledge. In the framework of ethnomathematics, as proposed by D'Ambrosio (2016), such systems are valid forms of mathematical practice embedded in cultural life.

In addition, Javanese culture possesses a rich and nuanced system of numerical terminology used to denote specific quantities based on the physical characteristics or conventional groupings of objects. For example, *ajar* or *saajar* refers to a whole orange, including its peel, while *gagang* or *sagagang* is used to count individual flower stems. Segments of rhizomes, such as ginger or turmeric, are measured using the term *grigih* or *sagrigih*, which signifies a single joint. Small fruits clustered on a single stem such as langsat or rambutan are grouped under the term *ombyok* or *saombyok*. Large branches of banana or coconut leaves are categorized as *janjang* or *sajanjang*, and individual rice stalks are counted using *wuli* or *sawuli*. The terms *bengkak* or *mata* (e.g., *sabengkak* or *samata*) denote individual *petai* (stink bean) seeds, while *eler* or *saeler* refers to a single cigarette. A full set of clothing, including accessories, is termed *pengadeg* or *sapengadeg*, and individual satay skewers are counted with *sunduk* or *sasunduk*. For palm sugar molded in half a coconut shell, the term *lining* or *salining* represents one piece. Betel leaves are counted using *candhik* or *sacandhik*, and a pair of earrings is expressed as *sele* or *sasele*. Tobacco boxes are referred to as *lampang* or *salampang*, while *wuku* or *sawuku* denotes a block of salt. Finally, folded items such as cloth or paper are quantified using *lempit* or *salempit*, signifying one-fold. These terms demonstrate the nuanced and context-sensitive numerical vocabulary embedded in Javanese linguistic and cultural practices, as shown in Figure 3.

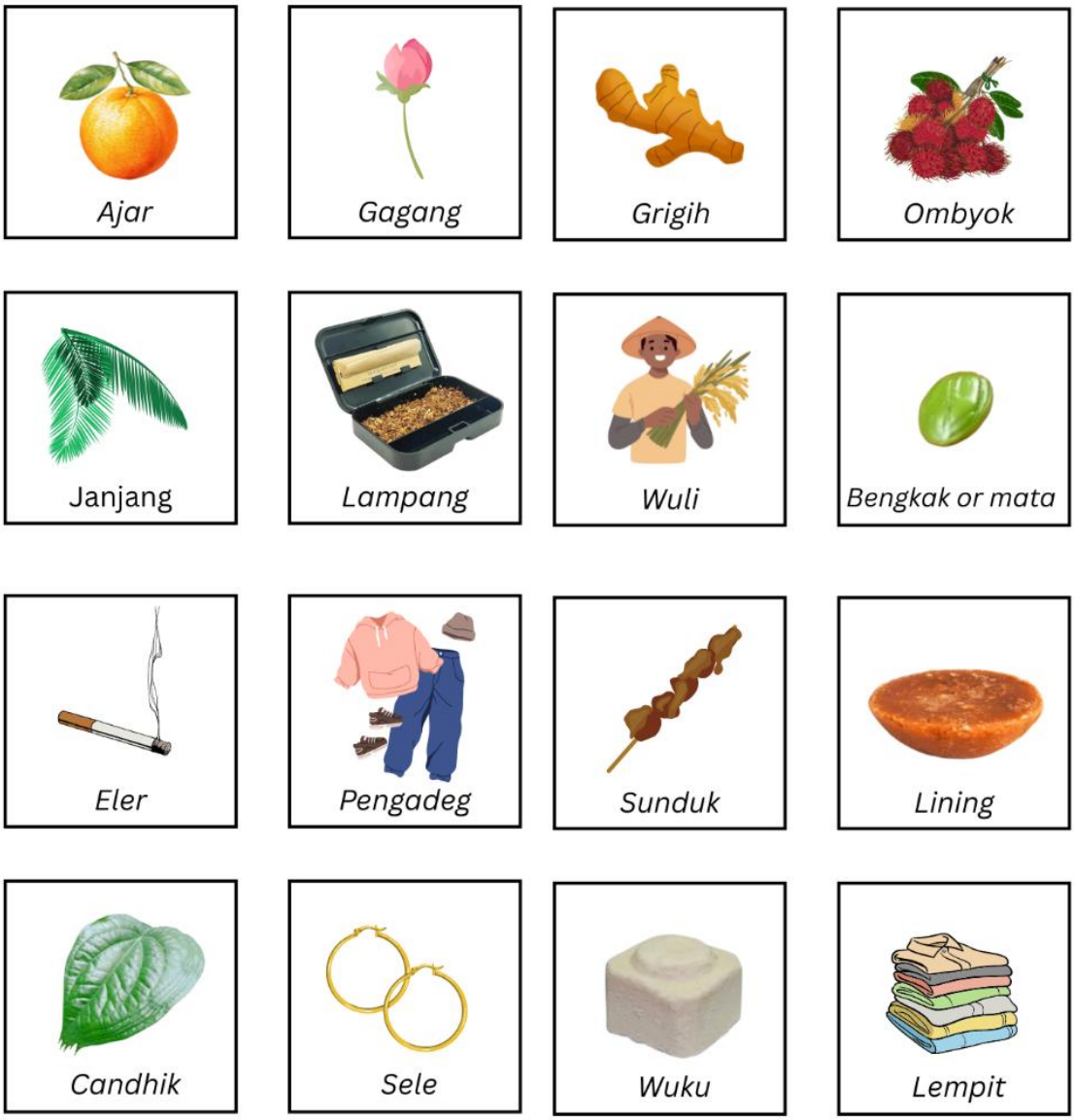

Figure 3. The illustration of Javanese numerical language for non-standard numerical units

Finally, recent studies further highlight similar patterns in other Indonesian cultural contexts. For example, Umbara (2024) found that the Sundanese numerical system includes unique representations in multiples of 25 and uses distinct terms for numbers between 21 and 29. Furthermore, Daniel et al. (2024) documented that the Dawan language dialect of Amanuban employs a base-10 system yet incorporates unique features for expressing digits 0 to 9. These findings collectively affirm that linguistic structures can offer rich mathematical meaning, enabling communities to engage in numerical reasoning through culturally embedded language.

3.2. Discussion

This section discusses the intersection between mathematics and Javanese cultural practices, particularly focusing on how local language and lived experiences shape numerical understanding and mathematical reasoning. Drawing on examples of indigenous number expressions and non-standard units, the analysis highlights how these culturally

embedded concept's function both in daily life and in informal learning contexts. The discussion is organized into three key parts, such as exploring how mathematical ideas are reflected in Javanese cultural practices and daily communication, considering how these insights can be integrated into culturally based mathematics education, and examining the practical and theoretical implications of incorporating local number systems and measurement units into formal mathematics instruction. Through this lens, the section aims to demonstrate how ethnomathematical perspectives can support meaningful, context-driven learning while preserving and valuing cultural knowledge.

3.2.1. Cultural Insight to Mathematics Learning and Practical Use in Daily Life

Mathematics is not always understood through formal symbols and numerical representations—particularly within traditional societies such as those in Javanese culture, where mathematical concepts are embedded in more contextual and culturally grounded forms. In daily life, the Javanese community employs specific terms in their native language to express number concepts and indeterminate units, which serve as concrete examples of ethnomathematical practices. For instance, terms like *siyung* (a clove of garlic), *lirang* (a hand of bananas), and *gagrang* (a set of household items) illustrate a system of indeterminate measurement units based on lived experience and adapted to the nature and context of specific objects. In the context of fractions, expressions such as *telung prapat* (three-fourths) or *separo* (one divided by two) are deeply familiar and frequently used in everyday conversation. These linguistic patterns demonstrate that the Javanese people have long possessed a form of mathematical understanding that is not necessarily expressed in numeric notation but instead communicated through local language and cultural practice.

Barton (2008) argues that mathematical systems rooted in local culture provide a strong conceptual foundation for learners to grasp abstract mathematical ideas because they are directly tied to real-life experiences. Such culturally relevant approaches not only strengthen numeracy skills but also embed cultural values and foster a sense of identity. These studies support the idea that local systems are essential for developing a meaningful and contextually grounded understanding of foundational mathematical concepts. Moreover, the use of basic number systems and indeterminate units in Javanese culture reveals a strong mathematical relationship between language and physical objects that are socially categorized. In the cognitive linguistic framework developed by Lakoff and Núñez (2000), language is not merely a tool for communication but also a reflection of how humans construct mathematical concepts mentally. Terms such as *sunduk* (skewer), *grigih* (a segment of ginger), or *candhik* (a folded betel leaf) exemplify how people use concrete physical experiences to form intuitive quantitative understanding.

Thus, the mathematical language of the Javanese community, particularly in the expression of indeterminate units, is not only a reflection of local wisdom but also holds significant pedagogical value. This approach can serve as a model for contextual mathematics education that integrates local culture with global mathematical concepts. Cultural integration in mathematics instruction can help students understand concepts and classifications in ways that are concrete, meaningful, and relevant to their everyday lives (Prahmana & Istiandaru, 2021).

3.2.2. Integration into Culturally based Mathematics Education

The integration of indigenous number concepts and non-standard measurement units into culturally based mathematics education can be effectively achieved by utilizing local terms and practices that have been passed down through generations, as observed in Javanese culture. For example, the introduction of fractions need not begin with formal symbols such as 1/2 or 3/4, but rather with culturally familiar terms like *separo* (1/2), *telung prapat* (3/4), or *liman praenem* (5/6), which have been widely used and were previously discussed in detail. Similarly, culturally specific non-standard units such as *siyung*, *lirang*, *tundhun*, and *gagrang* can be employed to introduce the concept of indeterminate measurement units in a way that aligns with students' everyday experiences.

This form of integration supports a constructivist approach to mathematics learning, where knowledge is built through learners' direct engagement with their environment. By leveraging language and practices that are already familiar, students are more likely to grasp abstract mathematical concepts, as these ideas are directly connected to their lived realities. This approach is consistent with Vygotsky's theory of the zone of proximal development, which suggests that educators can scaffold the transition from informal to formal mathematical understanding through culturally grounded learning experiences (Vygotsky, 1978). Activities such as counting *lirang* (hands of bananas) at the market or estimating *rempang* (bundles) of vegetables not only teach mathematical concepts but also cultivate cultural appreciation and identity among students.

3.2.3. Practical and Theoritical Impact of Integrating Number and Indefinite Unit Concepts into Culturally Based Mathematics Education

From a practical perspective, the integration of locally rooted number concepts and non-standard measurement units enriches learning resources and renders mathematics more meaningful for students. Rather than perceiving mathematics as an abstract and isolated discipline, students begin to see it as an integral part of their everyday lives (Rosa & Orey, 2011; Umbara, 2024). Daily activities such as market transactions or post-harvest management become authentic contexts for applying mathematical thinking. This strengthens the connection between numerical literacy and essential life skills, fostering functional competence in real-world settings.

Theoretically, this integration extends the scope of ethnomathematical theory by providing empirical evidence on how indigenous number systems and measurement units shape mathematical reasoning. It reinforces the idea that there is no single, universal way to understand or teach mathematics (Restivo, 1992). This perspective opens pathways for the development of more inclusive and context-responsive curricula that value and incorporate cultural diversity. By recognizing cultural specificity in mathematical practices, educators can design instruction that aligns with students lived experiences, fostering deeper engagement and comprehension.

Furthermore, local concepts of non-standard units such as *wungkus* (a bundle), *ombyok* (a cluster), and *candhik* (a folded leaf) enrich the pedagogy of measurement and estimation, which are critical components of 21st-century mathematics education. These culturally embedded units encourage flexible thinking and help students recognize that

quantity and size are often context-dependent rather than fixed or absolute. Such an approach nurtures adaptive reasoning and estimation skills, aligning well with modern educational goals that emphasize relevance, critical thinking, and cultural responsiveness.

4. CONCLUSION

This study has revealed the presence of culturally embedded mathematical language within the Javanese community, where specific numerical expressions and indefinite measurement units are articulated through traditional Javanese terms. These mathematical expressions, still actively used in rural areas, are deeply intertwined with everyday practices such as trade, labor, and interpersonal communication. The findings offer a comprehensive account of how ethnomathematical elements are embedded in linguistic and sociocultural practices, providing a valuable starting point for designing culturally responsive mathematics education. This cultural-linguistic knowledge can be meaningfully integrated into classroom instruction to enhance mathematical understanding among students, particularly those from rural or culturally rooted backgrounds.

Despite its contributions, this research is constrained by several methodological and contextual limitations. The focus was limited to traditional Javanese language and data collection relied heavily on ethnographic methods, including participant observation and interviews. While these approaches provided rich qualitative insights, they limit the generalizability of findings beyond the studied context. Furthermore, the absence of empirical testing within classroom settings and the lack of quantitative validation restricts the study's applicability to broader educational environments. These limitations underscore the need for further investigations employing mixed methods to triangulate findings and extend the scope to diverse cultural and regional settings across Indonesia.

Future research should conduct cross-regional comparisons of ethnomathematical language use to identify both variations and commonalities across Indonesia's diverse cultural contexts, thereby deepening the understanding of how local mathematical expressions reflect and influence cultural practices. Longitudinal studies are also essential to examine the sustained impact of integrating culturally embedded mathematical concepts on students' numeracy skills, conceptual development, and overall academic achievement. Moreover, given that the present study is theoretical in nature and lacks practical classroom application, empirical investigations are needed to explore how students engage with non-standard or informal measurement units in actual learning environments, and how these can serve as effective bridges to understanding standardized mathematical concepts, such as fractions and internationally recognized units. This line of inquiry also underscores the importance of policy support for developing culturally responsive instructional materials and fostering collaborative curriculum design involving educators, community members, and cultural experts. Such efforts have the potential not only to enhance mathematics learning outcomes but also to contribute to the preservation and revitalization of Indonesia's rich ethnomathematical heritage.

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